PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B21D 22/02, G02B 6/42

A1

(11) International Publication Number: WO 98/26885

(43) International Publication Date: 25 June 1998 (25.06.98)

(21) International Application Number: PCT/SE97/02084

(22) International Filing Date: 12 December 1997 (12.12.97)

(30) Priority Data:
9604682-6 19 December 1996 (19.12.96) SE

(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventors: BLOM, Claes; Sankta Ingridsväg 8, S-596 31 Skänninge (SE). LARSSON, Olle; Ruddammsvägen 35A, S-114 21 Stockholm (SE).

(74) Agent: TELEFONAKTIEBOLAGET LM ERICSSON; Patent & Trademark Dept., S-126 25 Stockholm (SE).

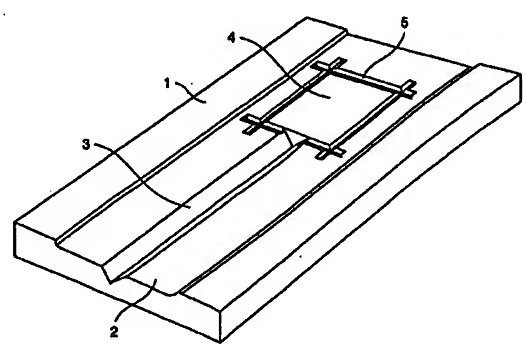
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

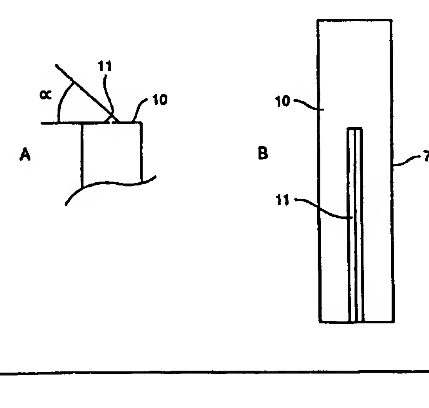
Published
With international search report.

(54) Title: MICRO-REPLICATION IN METAL

(57) Abstract

With the intention of preventing damage to components as a result of heating of a chip and with the intention of limiting the affect of such heating, a chip carrying a waveguide connection or a fibre connection has been soldered firmly onto a metal surface or directly onto a metal lead frame, wherewith the thermal resistance will be much lower than in the case when the chip is soldered onto a ceramic or silicon carrier. The use of an embossing tool having an active embossing/stamping part (7) enables a microstructure that includes a V-groove (3) to be produced in the metal surface at low cost and with great precision for aligning a waveguide or a fibre with the chip. The embossing process may be carried out on the metal surface or directly on the metal lead frame. An embossing process can be automated relatively easily, since the material to be embossed can be worked in strip form. A construction method in which an optical chip is soldered to a metal carrier in which waveguide receiving or fibre receiving grooves have been embossed therein will improve heat dissipation and thus substantially increase the useful life of the finished component.





FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

MICRO-REPLICATION IN METAL

FIELD OF INVENTION

The present invention relates to a method of micro-replication in metal, a device for producing micro-replications in metal and to a metal micro-replicated element produced in accordance with the invention. Micro-replicating methods and devices are preferably intended for use in producing with great precision and at low costs reproduceable building optocomponents, contact devices or other precision elements adapted for aligning optical chips with waveguides or fibres. An optocomponent building element that has an aligning facility can be readily mounted on a circuit board while connected to a waveguide or to a fibre and to a laser or a photodiode.

DESCRIPTION OF THE PRIOR ART

A common method of aligning optical chips with waveguides or fibres in optocomponents is to etch a desired microstructure in silicon in the form of a V-groove into which a waveguide or fibre can be fitted. With techniques used at present, optical chips are often solder-mounted on a ceramic or silicon carrier. This method quickly presents problems with respect to the dissipation of heat generated in the mounted component. This problem is particularly pronounced in the case of mounted semiconductor lasers of small dimensions, with which the heat generating region is concentrated to narrow bands of *circa* 2 μm that extend transversely through the chip close to its surface.

SUMMARY OF THE INVENTION

With the intention of preventing damage to the chip as a result of its becoming hot, or with the intention of at least limiting the affects of such heating, a chip that carries a waveguide or fibre connection has been soldered either to a metal carrier or to a metal lead frame, wherewith the thermal resistance will be much lower than when the chip is solder-mounted on a ceramic or silicon carrier. The invention enables a microstructure to be produced with great precision with respect to the alignment of a waveguide or a fibre in a metal surface with the aid of an embossing/stamping tool at low cost.

The embossing process may be carried out on a metal carrier or directly on a metal lead frame intended for plastic encapsulation. An embossing process can be automated relatively easily, since the material to be embossed can be worked in the form of short strips or in the form of long strips wound onto reels. An assembly in which optical chips are soldered onto metal carriers provided with embossed waveguide or fibre receiving grooves will result in improved heat dissipation and therewith greatly increase the useful life of the finished component with enhanced mean fault time (MFT).

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a metal element provided with a microstructure in accordance with the invention.

Figures 2A and B show respectively an inventive embossing tool from beneath and in section.

Figures 3A and B are detailed illustrations of the active part of the inventive embossing tool, seen from one side and from above.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Practical trials have shown that it is possible to emboss microstructures in copper with repeated high measurement precision and with only slight wear on the embossing tool used. Microstructures embossed in metal carriers enable optical components to be aligned and mounted directly on a copper lead frame or a lead frame made of some other alloy, for later inclusion as a building element in a plastic capsule, for instance.

The embossing technique provides two obvious advantages over known techniques in which lasers are mounted on a carrier which is then mounted on a lead frame. Firstly, the costs entailed by purchasing and producing such carriers are eliminated. Secondly, advantages are also afforded with respect to dissipation of the heat that is generated in the active regions of the lasers. However, there is the added cost of the embossing process and of the tool required herefor. The precision tools to be used to emboss micro replications may be manufactured by grinding or otherwise working the tool material directly, or in the following manner, for instance:

- Applying a photoresist to a silicon disc.

- Fitting a photomask having a suitable groove pattern over the silicon disc.

- Exposing the photoresist in those openings present in the photomask.

- Washing away exposed resist or, alternatively, unexposed resist.

- Etching the desired structure in the disc.

- Washing away photoresist residues.

This results in a plurality of mutually identical three-dimensional silicon structures in the case of two-dimensional photomasks. The aforesaid technique is known to the art, but is mentioned here to provide a better overall picture of the procedure used to produce an embossing tool with desired precision. This procedure can be continued in accordance with either one of the two alternative methods described below.

Alternative A

1. A patterned silicon disc is coated with a layer of material that possesses sufficient hardness.

2. The disc is plated with nickel or some other suitable material.

3. The plating is planarised.

4. The silicon is etched so as to separated the plated and planarised moulding therefrom. The hardness of the plated surface can be enhanced by sputtering or further plating the surface with an appropriate metal.

5. The moulding is sawn in two, so as to separate the mutually identical structures.

6. A structure is placed in a holder in an embossing tool, said holder being adapted to the structure.

7. The various parts of the embossing tool are assembled to provide a finished embossing tool.

Alternative B

1-4. According to Alternative A.

5. The non-planarised side is coated with a layer which makes later separation possible.

6. The disc is plated with nickel or some other metal.

7. The plating is planarised.

8. The two planarised mouldings are separated from one another.

9. The moulding is sawn in two so as to separate the mutually identical structures.

10. The moulding is placed in a holder and subjected to spark processing in an electro discharge machine (EDM).

11. Spark processing is effected directly in the material in which microstructures shall be embossed in the metal/lead frame.

12. The various parts of the embossing tool are assembled to provide a finished embossing tool.

Figure 1 illustrates an example of an embossed microstructure in a metal element 1 that has a recessed or sunken surface 2 which includes a V-groove 3 for aligning an optofibre or a waveguide. To facilitate mounting of a chip, the metal surface may also be provided with a chip mounting surface 4 that includes chip positioning markings in the form of grooves 5. The embossed metal surface enables a chip to be aligned with a waveguide or a fibre with a great degree of accuracy.

As evident from Figures 2A and B, the embossing tool 6 may have the form of a stamp with which a protective holder 8 is arranged around the active part 7 of the tool. The active tool part will suitably have a configuration with which grooves, such as V-grooves, can be embossed in a metal surface. The protective holder will be sprung, e.g. with an Adiprene plate 9, so as to be able to expose the active tool part in the actual embossing process.

Figures 3A and B show that the active part 7 may be configured with an embossing surface, which in this case is comprised of a flat surface 10 and a ridged area 11 such as

to form a planar surface, or alternatively a recessed surface, and a V-groove when embossing a metal surface. In order to enable an optofibre to be fitted in the V-groove, the active tool part may have a width of 1.20 mm for instance, and the width of the ridge may be 0.16 mm and its length 3.20 mm, and the angle α may be 45°.

With this micro replication in metal, a carrier in the form of lead frames and in strip form for instance, may be provided automatically in a manufacturing process with V-grooves and connected to a chip such as lasers or photodiodes. Waveguides or fibres can then be aligned automatically with the aid of the embossed grooves so as to obtain correct alignment of the waveguide or the fibre with the carrier mounted laser or photodiode. The inventive embossing technique enables micro replication to be achieved in the automatic manufacturing process to a high degree of reliability and with great precision at low costs.

It will be understood that the invention is not restricted to the aforedescribed and illustrated exemplifying embodiment thereof, and that modifications can be made within the scope of the following Claims.

CLAIMS

1. A method of micro replicating in metal such as to provide in a metal surface a structure for aligning at least one waveguide or at least one fibre for instance, **characterized** by embossing at least one groove, such as a V-groove, in a metal surface with the aid of an embossing tool, wherein the groove is intended to receive a waveguide or a fibre for alignment of said waveguide or fibre with a laser or photodiode mounted on the metal surface, for instance.

2. Means for carrying out micro replication in metal to provide a structure for, e.g., the alignment of at least one waveguide or fibre, **characterized** in that said means is an embossing tool (6) whose active part (7) has a configuration (11) which will provide at least one groove, such as a V-groove, in the metal surface when embossing said surface, wherein the groove is intended to receive a waveguide or fibre for the alignment of said waveguide or fibre with, e.g., a laser or a photodiode mounted on the metal surface.

3. Means according to Claim 2, **characterized** in that the active part (7) is comprised of a plated and planarised metal element separated from a silicon disc in which the structure has been etched, wherein the metal structure has a configuration (11) which in the embossing process will form at least one waveguide or fibre receiving groove, such as a V-groove, in the metal surface.

4. Means according to Claim 2, **characterized** in that the active part (7) has been ground to a configuration (11) which in the embossing process will form at least one waveguide or

fibre receiving groove, such as a V-groove, in the metal surface.

5. A micro-replicated metal element having in one surface thereof a structure for, e.g., aligning at least one waveguide or at least one fibre, **characterized** in that the structure included in the metal surface (1) comprises at least one groove (3), e.g. a V-groove, in which a waveguide or a fibre can be fitted for alignment of said waveguide or said fibre with, e.g., a laser or a photodiode mounted on said metal surface.

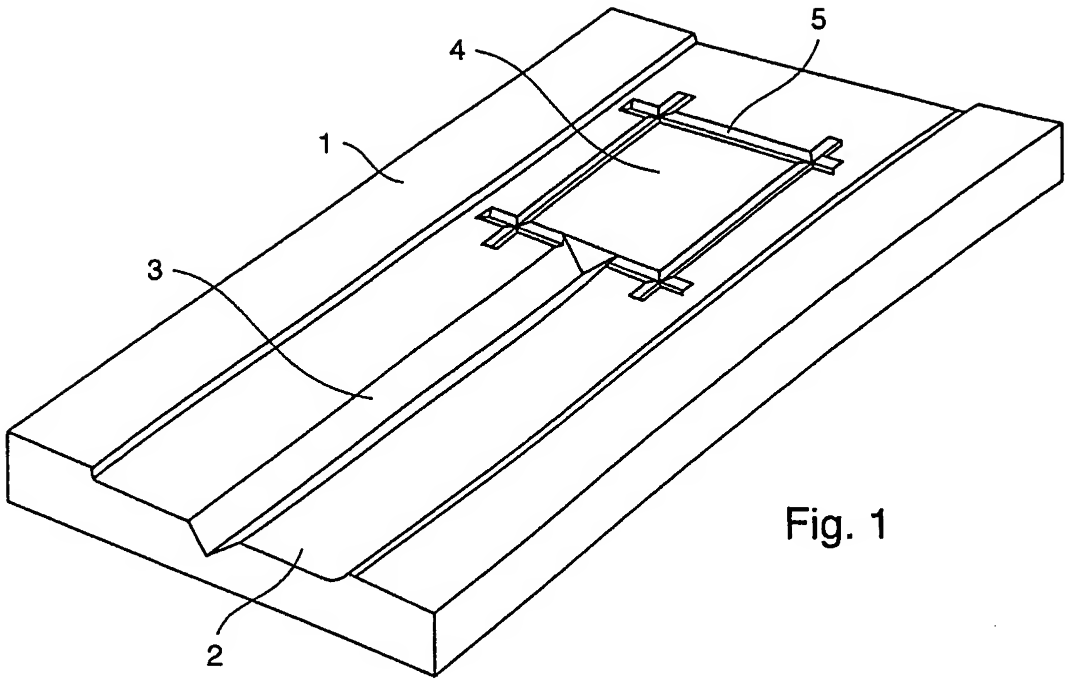


Fig. 1

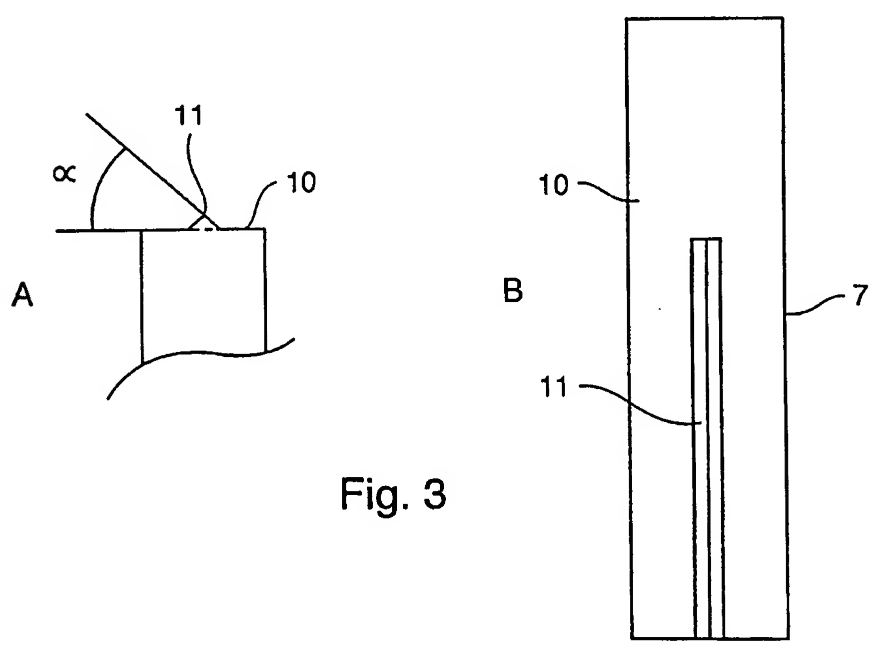
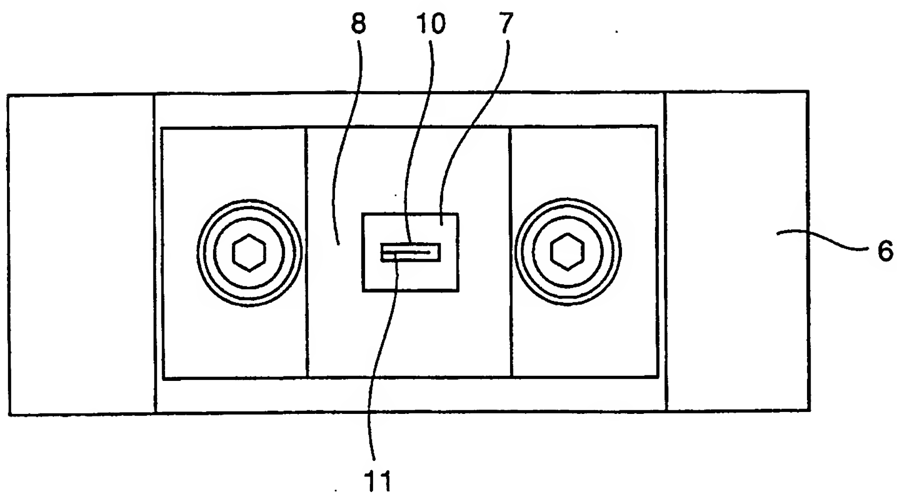


Fig. 3

A



B

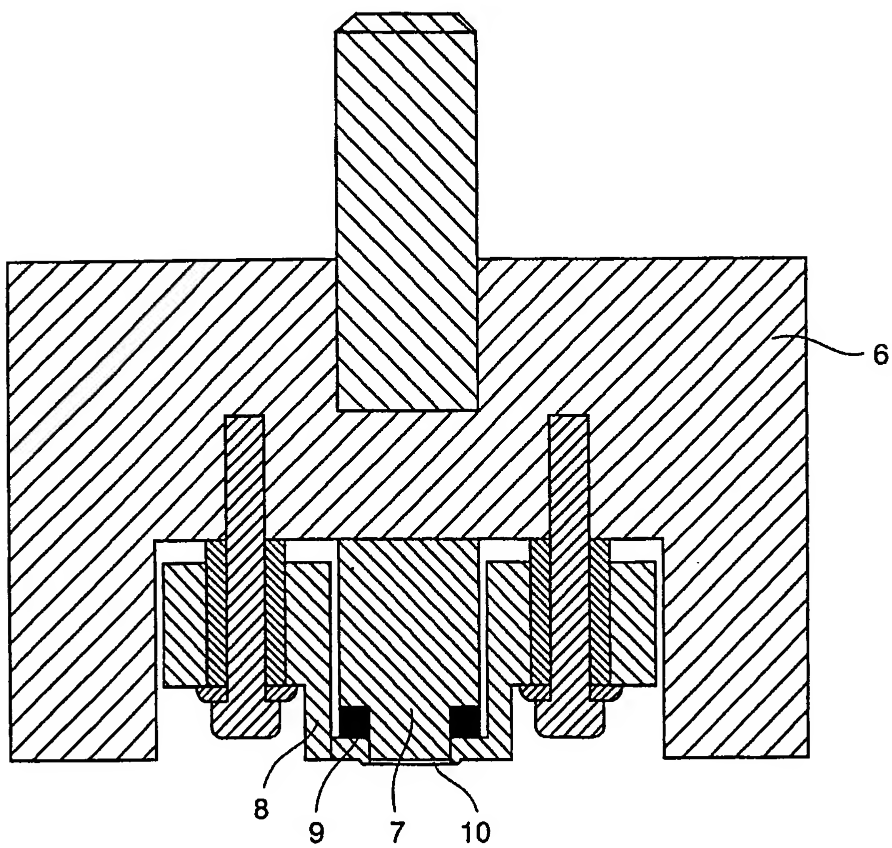


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/02084

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B21D 22/02, G02B 6/42
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B21D, B44B, B44C, G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4411057 A (DUDA ET AL), 25 October 1983 (25.10.83), figures 1,3, claim 1, abstract --	1,3,5
A	DE 3307669 A1 (LICENTIA PATENT-VERWALTUNGS-GMBH), 6 Sept 1984 (06.09.84), figures 1-4, abstract --	1-5
A	EP 0217063 A1 (SIEMENS AKTIENGESELLSCHAFT BERLIN UND MüNCHEN), 8 April 1987 (08.04.87), figures 1-5, abstract --	1-4
A	WO 9416348 A1 (ROBERT BOSCH GMBH), 21 July 1994 (21.07.94), figures 1-5, abstract --	1-5

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" erlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 March 1998	02 -04- 1998

Name and mailing address of the ISA/	Authorized officer
Sw dish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Katarina Ekman Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/02084

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0731365 A2 (ROBERT BOSCH GMBH), 7 March 1995 (07.03.95), figures 1-5, abstract --	1-5
A	US 4307932 A (WINZER), 29 December 1981 (29.12.81), figures 1-3 --	1-5
A	DE 4137539 A1 (DIGITAL EQUIPMENT INTERNATIONAL GMBH), 19 May 1993 (19.05.93), figures 1-3, abstract --	1-5
A	EP 0331338 A2 (AMERICAN TELEPHONE AND TELEGRAPH COMPANY), 6 Sept 1989 (06.09.89), figures 1-13, abstract -- --------	1-5

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/02/98

International application No.
PCT/SE 97/02084

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4411057 A	25/10/83	CA 1164700 A	03/04/84
		EP 0006042 A,B	12/12/79
		FR 2426347 A,B	14/12/79
		JP 54150993 A	27/11/79
DE 3307669 A1	06/09/84	NONE	
EP 0217063 A1	08/04/87	DE 3531734 A	12/03/87
		JP 62057277 A	12/03/87
		US 4768199 A	30/08/88
WO 9416348 A1	21/07/94	DE 4300652 C	31/03/94
		EP 0630486 A	28/12/94
		JP 7504770 T	25/05/95
		US 5475775 A	12/12/95
		US 5574806 A	12/11/96
EP 0731365 A2	07/03/95	DE 19508025 A	12/09/96
US 4307932 A	29/12/81	DE 2744128 A	12/04/79
DE 4137539 A1	19/05/93	NONE	
EP 0331338 A2	06/09/89	SE 0331338 T3	
		CA 1309157 A	20/10/92
		DE 68918133 D,T	12/01/95
		ES 2058498 T	01/11/94
		HK 191995 A	29/12/95
		JP 2005611 C	11/01/96
		JP 2009187 A	12/01/90
		JP 7034495 B	12/04/95
		SG 154394 A	17/03/95
		US 4904036 A	27/02/90